Bismuth

From Wikipedia, the free encyclopedia

Bismuth (IPA: ['bɪzməθ]) is a chemical element that has the symbol **Bi** and atomic number 83. This heavy, brittle, white crystalline trivalent poor metal has a pink tinge and chemically resembles arsenic and antimony. Of all the metals, it is the most naturally diamagnetic, and only mercury has a lower thermal conductivity.

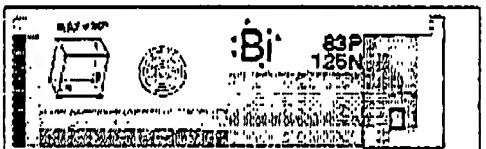
Bismuth compounds are used in cosmetics and in medical procedures. As the toxicity of lead has become more apparent in recent years, alloy uses for bismuth metal as a replacement for lead have become an increasing part of bismuth's commercial importance.

Contents

Notable characteristics

Bismuth is a brittle metal with a pinkish hue, often occurring in its native form with an iridescent oxide tarnish showing many refractive colors from yellow to blue. When combusted with oxygen, bismuth burns with a blue flame and its oxide forms yellow fumes. Its toxicity is much lower than that of its neighbors in the periodic table such as lead, thallium, and antimony.

No other metal is more naturally diamagnetic (as opposed to superdiamagnetic) than bismuth, and it has a high electrical resistance. Of any metal, it has the second lowest thermal conductivity and the highest Hall effect. When deposited in sufficiently thin layers

83	lead ← bismuth → polonium
Sb ↑ **Bi** ↓ Uup	 Periodic Table - Extended Periodic Table

General	
Name, Symbol, Number	bismuth, Bi, 83
Chemical series	poor metals
Group, Period, Block	15, 6, p
Appearance	lustrous pink 
Standard atomic weight	208.98040(1) $g \cdot mol^{-1}$
Electron configuration	$[Xe]\ 4f^{14}\ 5d^{10}\ 6s^2\ 6p^3$
Electrons per shell	2, 8, 18, 32, 18, 5
Physical properties	
Phase	solid
Density (near r.t.)	9.78 $g \cdot cm^{-3}$
Liquid density at m.p.	10.05 $g \cdot cm^{-3}$
Melting point	544.7 K (271.5 °C, 520.7 °F)
Boiling point	1837 K (1564 °C, 2847 °F)
Heat of fusion	11.30 $kJ \cdot mol^{-1}$
Heat of vaporization	151 $kJ \cdot mol^{-1}$
Heat capacity	(25 °C) 25.52 $J \cdot mol^{-1} \cdot K^{-1}$

Vapor pressure

P(Pa)	1	10	100	1 k	10 k	100 k
at *T*(K)	941	1041	1165	1325	1538	1835

Atomic properties	
Crystal structure	rhombohedral
Oxidation states	3, 5 (mildly acidic oxide)
Electronegativity	2.02 (scale Pauling)
Ionization energies (more)	1st: 703 $kJ \cdot mol^{-1}$

on a substrate, bismuth is a semiconductor, rather than a poor metal. [1]

Elemental bismuth is one of very few substances of which the liquid phase is denser than its solid phase (water being the best-known example). Because bismuth expands on freezing, it was long an important component of low-melting typesetting alloys, which needed to expand to fill printing molds.

While bismuth was traditionally regarded as the element with the heaviest stable isotope, it had long been suspected to be unstable on theoretical grounds. This was finally demonstrated in 2003 when researchers at the Institut d'Astrophysique Spatiale in Orsay, France, measured the alpha emission half-life of ^{209}Bi to be 1.9×10^{19} years, [2] over a billion times longer than the current estimated age of the universe. Due to its extraordinarily long half-life, for nearly all applications bismuth can be treated as if it is stable and non-radioactive. The radioactivity is of academic interest, however, because bismuth is one of few elements whose radioactivity was suspected, and indeed theoretically predicted, before being detected in the laboratory.

	2nd: 1610 kJ·mol^{-1}
	3rd: 2466 kJ·mol^{-1}
Atomic radius	160 pm
Atomic radius (calc.)	143 pm
Covalent radius	146 pm
Miscellaneous	
Magnetic ordering	diamagnetic
Electrical resistivity	(20 °C) 1.29 µ Ω·m
Thermal conductivity	(300 K) 7.97 W·m^{-1}·K^{-1}
Thermal expansion	(25 °C) 13.4 µm·m^{-1}·K^{-1}
Speed of sound (thin rod)	(20 °C) 1790 m/s
Young's modulus	32 GPa
Shear modulus	12 GPa
Bulk modulus	31 GPa
Poisson ratio	0.33
Mohs hardness	2.25
Brinell hardness	94.2 MPa
CAS registry number	7440-69-9

Selected isotopes

Main article: Isotopes of bismuth

iso	NA	half-life	DM	DE (MeV)	DP
^{207}Bi	syn	31.55 y	ε, β$^+$	2.399	^{207}Pb
^{208}Bi	syn	368,000 y	ε, β$^+$	2.880	^{208}Pb
^{209}Bi	100%	$(19 \pm 2) \times 10^{18}$ y	α		^{205}Tl

References

History

Bismuth (New Latin *bisemutum* from German *Wismuth*, perhaps from *weiße Masse*, "white mass") was confused in early times with tin and lead due to its resemblance to those elements. Basilius Valentinus described some of its uses in 1450 . Claude François Geoffroy showed in 1753 that this metal is distinct from lead.

Artificial bismuth was commonly used in place of the actual mineral. It was made by hammering tin into thin plates, and cementing them by a mixture of white tartar, saltpeter, and arsenic, stratified in a crucible over an open fire.[3]

Bismuth was also known to the Incas and used (along with the usual copper and tin) in a special bronze alloy for knives, [2] (http://adsabs.harvard.edu/abs/1984Sci...223..585G)

Occurrence

In the Earth's crust, bismuth is about twice as abundant as gold. It is not usually economical to mine it as a primary product. Rather, it is usually produced as a byproduct of the processing of other metal ores, especially lead, but also tungsten or other metal alloys.